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The Relationship Between Information and Communication Technology (ICT), International Migration and Economic Growth in Turkey

(Research Article)

Türkiye'de Bilgi ve İletişim Teknolojileri (BİT), Uluslararası Göç ve Ekonomik Büyüme Arasındaki İlişki

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ABSTRACT

The paper examines the information and communication technology-international migration-economic growth nexus for Turkish economy using annual time series data covering the period of (1998-2019). Toda-Yamamoto Causality Test (TY) was used in the application of econometric method The results obtained indicated that there is a unidirectional causality from international migration to economic growth in the long run for Turkey. This is inline with the empirical evidences that external immigrant movements can promote economic growth in receiving country. Although the form of migration to Turkey is unclear in terms of skilled or unqualified labor force, international migrants, even including daytripper workers from neighbour countries, boost the economic activities especially in agriculture, construction and service sectors in Turkey. The paper also concluded that there is a one-way causal relationship between ICT and economic growth. The ICT usage can make a substantial contribution to economic growth of Turkey so Turkish government should improve the infrastructure of Internet and mobile phone with a conscious policy initiative. Besides, lastly, it is observed that there is not a causal relationship between migration and ICT at 5 % for Turkey. It's found that there is a unidirectional causality from migration to ICT at 10 %.

1. INTRODUCTION

The twenty-first century brought a substantial increase in the size of immigrant population in the world. While 173 million people did not live in the country where they were born in 2000, this number reached approximately 273 million in 2019 (UN, 2019). Just like economic, political and religious factors, advances in information and communication technologies (ICTs) can be a driving force in people's mobility. Thus, The development of modern communication

technologies has enabled the rapid growth of migration by facilitating the availability of information. (Kotyrlo, 2019).

We can illustrate the undeniable effect of technology on migration with its effects on general political and social developments such as the Arab Revolution. It eases not only the mobility of individuals across the world and but also the formation, growth and maintenance of family ties and diaspora communities. Particularly, immigrants create, maintain and develop their formal and informal networks in both the real and digital world, using personal computers, mobile phones and Internet access, which have now become mundane tools. These technological developments also impower and form the sense of individual and collective identity of the migrants (Oiarzabal and Reips, 2012). Studies revealed that ICTs are substantial tools in helping the process of "connected" migrants' integration. Moreover, empirical studies asserted that low-skilled as well as forced migrants, namely refugees, are impowered through the strategic use of ICT (Nedelcu and Soysüren, 2020).

In today's digital world, ICT also serves a crucial function in prompting economic growth (Lee and Brahmasrene, 2014; Rohman and Bohlin, 2014; Pradhan et al, 2018; Majeed and Ayub, 2018; Bilan et al, 2019). ICT contributes the growth through three channels: i) ICT supports both a growing use or continuous advances in performance, so ICT can be used as a factor of production; ii) the production of ICT contributes to productivity with very high advances, and it's importance has rised over the past few decades; iii) externalities (Banque de France, 2016).

In general, the effect of ICT on growth in developing countries differs from that in developed countries. This may be due to a variety of factors. For example, Developing countries may lack absorptive capacities such as adequate human resources or other complementarity factors such as R&D expenses. This is one of the reasons why they benefit less from ICT investments than developed countries. Another reason is that ICT could provide developing countries to give small and incremental innovations and methods of increasing productivity (Niebel, 2018). All of these features suggest that ICTs have the ability to promote "leapfrogging," a form of development technique. Since the technological and institutional infrastructures of the industrialized countries have been developed before, they are locked to higher level technologies. However, since developing countries do not complete their basic technology infrastructures, this state of being late theoretically offers these countries the possibility of leaping directly to superior technologies. Since these countries, which have not yet completed their industrialization process, can bypass some stages of development by directing their future investments to the latest technologies and they can turn this backwardness into an advantage by taking advantage of the latest technological developments. That is called "leapfrogging hypothesis" (Steinmueller, 2001).

There are many previous studies (Yapraklı and Sağlam, 2010; Algan et al., 2017, Özkan and Çelik, 2018) regarding the effect of ICT on growth and studies (Meçik and Koyuncu, 2020) about international migration-economic growth nexus in Turkey. As a contribution to the literature, this paper will test the role of ICT on both external immigration movements to Turkey and economic growth in Turkey. Because Turkey is a country where there is an intense international migrant movements, observing the ICT effect on external immigration to Turkey also constitutes the original value of this study.

The rest of the paper is structured as follows: Section 2 examines the literature on the relationship between ICT, international migration and economic growth. Section 3 discusses

the methodology including sources of data, model specification and tools of analysis. Section 4 discusses analytical observations and conclusions from the effect of ICT on foreign migration flows and economic growth in Turkey, while Section 5 concludes and makes policy recommendations.

2. LITERATURE REVIEW

2.1 Theoretical Literature Review

There are many economic growth theories developed in order to determine the factors of economic growth. Classical and neoclassical theories are old economic growth theories and consider land, labor and physical capital as main factors of economic growth. Romer (1986) and Lucas (1990) added the human capital factor in growth models and became a pioneer in growth theories. According to these theories called as endogenous growth theories, human capital, innovation and knowledge are main endogenous factos and primary contributors to economic growth. These modern theories also contend that investments in ICT are crucial to growth. (Majeed and Ayub, 2018).

Castells was one of the social leading theorist to originate the concept of "information society" in his book (Castells, 2004) in 1990s. Similarly, his economic network theory was an emerging academic area that applies scientific models to economic analysis. The "information society" concept suggested that the world is transforming itself from Industrial Age to a new era, where the ideas and knowledge become the new booster of power and sustainable development when they are shared (Iqbal et al., 2020). At this point, it was thought that the spread of new ICT technologies will be get easier by migration activities and that permanent settlement of migrants will positively affect economic growth by contributing to entrepreneurship and physical capital (Miracle and Berry, 1970).

Technology definitely has been affecting migration theories since 1990s. Before technology was considered as a tool of removing uncertainty of migrant movements, The Harris-Todaro Model (1970) was the first theory that explained the "uncertainty" concept of migration. In later stages, new models were developed for international migrants to obtain information about the countries they go (Zelinsky, 1971; Maier, 1985; Berninghaus & Seifert-Vogt, 1991). At this point, Zelinsky's Mobility Transition Theory asserted that migration tends to increase in the early phases of growth. Improvements in transport and communication, flows of knowledge, a perceived lack of local economic opportunities, and growing level of welfare stimulate people to migrate. Faist (2000) underlined the meso-level of migration and contributed to Network Theory. According to Faist, social connections and social resources in families, neighbourhoods, and more structured organizations assist migrants in the migration decision and adaptation process, serving as a platform as well as an integration mechanism. In this context, modern communication technologies like Internet, mobile devices, satellite Tv empowered the network between international migrants and their country of origin and reduced uncertainty. Therefore, Network Theory of migration has been gaining importance since 2000s and it leads new migration types like temporary and circular migration, which are based on the strong connection of migrants with their homelands.

2.2 Empirical Literature Review

In empirical literature, there are generally positive signs between economic growth-international migration nexus for developing countries. For example, Maria and Lazarova

(2012) investigated the relationship between migrant movements, human capital and GDP with regression and simulation analyzes for the period 1990-2000 in 130 developing countries. There is a statistically significant impact of migration on both the level and composition of human capital. In addition, it has been seen that it has an effect on growth. Boubtane et al. (2014) studied the relationship between 22 OECD countries 1986-2006 GMM and economic growth and migration. It is concluded that the human capital created by the immigrants positively affects the economic growth. Altunç et al. (2017) analyzed the relationship between economic growth, inflation, unemployment in Turkish economy and also international migration to Turkey for the period 1985-2015. The study found that there is a bilateral causality between external immigration and economic growth in Turkey, according to Granger Causality test result. Recently, Meçik and Koyuncu (2020) determined the causality relationship between economic growth of Turkey and international migration flows to Turkey using Toda-Yamamoto technique for the period 1991-2018. They discovered that there is a unidirectional causality from migration to economic growth.

When it comes to estimating the impact of ICT on migration, the findings of existing studies mostly point out a mixed relationship. Cooke and Shuttleworth (2017) used data from the US panel study of income dynamics and found a significant negative impact of ICT usage on regional domestic migration within the United States. According to the study, negativeness between ICT and migration relationship asserts that ICTs may hinder migration because it basically reduces the costs of not moving. Onitsuka and Hidayat (2018) conducted a questionnaire survey in a rural district of Indonesia to test the interactive ICT- migration nexus. After obtaining data from 142 youths under 25 years of age, they concluded that approximately 25% of the respondents had purposes of migration and there was no clear difference between the migration intentions of young people who use Internet and who do not. Kotyrlo (2019), investigated the ICT- migration nexus for 191 countries, for the period of 1995-2015 and confirmed the negative link between changes in ICT development and migration intensity. Using panel data from 59 Belt and Road Initiative (BRI) countries from 2000 to 2017, Iqbal et al (2020) determined that there is a positive and significant association between ICT and migration in BRI countries. They employed panel unit root tests, fully modified OLS method, and Granger causality analysis. They also opined that there is also a positive relationship between ICT and economic growth in these countries. Reversely, Hübler (2016) investigated and compared the role of international and domestic migration in technology diffusion. The study applied data from developing Southeast Asian countries as a model research area. The results show that total emigration as well as immigration can support technology diffusion with the widespread use of mobile phones and internet.

There are numerous empirical studies on developing countries that investigate the ICT-economic growth nexus. For example, Sridhar and Sridhar (2009) investigated the link between telecommunications and economic growth in developing countries. When they controlled for the effects of capital and labor, they found that cellular networks have a major impact on national output. Hong (2017) examined the connection between economic growth and R&D investment for Korea's ICT industry. In the analysis, the author discovered bidirectional causality. The findings have revealed that private ICT R&D investment has a closer association with economic growth than public ICT R&D investment. Niebel (2018) analyzed the impact of ICT on economic growth in developing and developed countries. The study is focused on a high-quality survey of 59 countries from 1995 to 2010. He found a positive link between ICT and economic growth. The results also indicate that developing countries are not benefiting

more from investments in ICT than developing countries. Majeed and Ayub (2018) analyzed the impact of ICT indicators on economic growth in 149 countries globally and regionally within the range of 1980 and 2015. The study applied some methods including Ordinary Least Squares (OLS), pooled OLS, Two Stage Least Squares (2SLS) and Generalized Method of Moments (GMM). They concluded that all indicators of ICT increase both regional and global economic growth. However, they found that some indicators such as online service, telecommunication infrastructure and e-government are comparatively more conducive in accelerating economic growth. Adeleye and Eboagu (2019) evaluated the impact of ICT on economic growth in 54 African countries for the period 2005-2015. Empirical evidence was based on GMM Method. They employed the individuals using the Internet, mobile phone and fixed telephone subscribers as ICT indicators. The results showed that economic growth is positively and significantly affected by ICT development.

There are also some works which investigate the causality between ICT and economic growth for Turkey. Yapraklı and Sağlam (2010) examined the relationship between ICT and economic growth in Turkey from 1980 to 2008. Multivariate cointegration analysis, error correction-augmented Granger causality tests, and vector error correction methods were used. They found that there is a bidirectional Granger causality both from ICT to economic growth and economic growth to ICT in Turkey. Türedi (2013) discovered the effect of ICT on growth in 53 countries, including Turkey, between 1995 and 2008. Empirical analysis was employed through panel data techniques. It has been concluded that the power of ICT to affect GDP is closely related with the development level of the countries. Although this level is higher in developed countries, it has been concluded that it is positive in not only developed but also in developing countries. From a different perspective, Malatyalı (2016) analyzed the impact of technology transfer on economic growth in Turkey using Granger Causality Test for the period 1989-2014. The study found that there is a unidirectional causality from economic growth to technology transfer. Özkan and Çelik (2018) investigated the impact of ICT on economic growth in Turkish economy within the range of 1998 and 2015. They used economic growth as dependent variable while they took internet and mobile phone usage as independent variable. They applied the unit root test and granger causality test and found that ICT affects positively on economic growth.

3. DATA AND METHODOLOGY

The data is comprised of time series data of ICT, international migration and economic growth for Turkey annually. The data ranges from 1998 to 2019. ICT data is obtained through the people who are Internet subscribers in Turkey. International migration includes external movement across the national border of Turkey based upon the inflows per year. Economic growth is the gross domestic product per capita in Turkey. Data of ICT is obtained from Turkstat "TÜİK", Ministry of Transport and Infrastructure, Information and Communications Technologies Authority. Data of international migration is obtained from Turkish General Directorate of Investment and Businesses' Border Statistics and data of economic growth is obtained from WORLD BANK's GDP database. The logarithm of all series are taken in order to purify the series from small fluctuations and make them linear. Accordingly, LICT denotes information and communication technology, LIMI denotes international migration and LGDP stands for economic growth.

Since the variables used in the econometric analysis are not stationary, there will be a regression fallacy problem. Therefore, it is essential to examine the stationarity of the data before starting

the analysis. Various unit root tests are used to study stationarity. ADF unit root test was used in the analysis. The test was carried out using on both constant (intercept) only and constant with trend in order to see how robust the outcome will be.

Toda-Yamamoto (1995) causality test (TY) was employed in the paper so that the causality relationship between Turkey's ICT, economic growth and international migration can produce a robust outcome. In the TY method, series can be included in the analysis without the need for information such as stationarity and cointegration, which can reduce the loss of information and observation (Göçer ve Akın, 2016). Due to the fact that some of the series are I (1) and some of them are I (2), the TY causality test method that allows to work with the level values of the series or to apply different values of the series has been preferred.

As the first step of the TY method, the lag length (k) suitable for the VAR model is determined. In the second stage, the integration level dmax of the variable with the highest degree of integration is added to the k lag length. In the third stage, the level values of the series and the VAR model are estimated for the lag (k + dmax). The three-variable VAR model to be estimated at this stage is given below:

$$LICT_t = \alpha_0 + \sum_{i=1}^{k+d\ max} \alpha_{1i} LICT_{t-1} + \sum_{i=1}^{k+d\ max} \alpha_{2i} LGDP_{t-1} + \sum_{i=1}^{k+d\ max} \alpha_{3i} LIMI_{t-1} + \mu_t \quad (1)$$

$$LGDP_t = \beta_0 + \sum_{i=1}^{k+d\ max} \beta_{1i} LGDP_{t-1} + \sum_{i=1}^{k+d\ max} \beta_{2i} LICT_{t-1} + \sum_{i=1}^{k+d\ max} \beta_{3i} LIMI_{t-1} + \mu_t \quad (2)$$

$$LIMI_t = \gamma_0 + \sum_{i=1}^{k+d\ max} \gamma_{1i} LIMI_{t-1} + \sum_{i=1}^{k+d\ max} \gamma_{2i} LICT_{t-1} + \sum_{i=1}^{k+d\ max} \beta_{3i} LGDP_{t-1} + \mu_t \quad (3)$$

Hypotheses used in the study are;

H_0: ICT is not the cause of economic growth.

H_0 : Economic growth is not the cause of ICT.

H_0: International migration is not the cause of economic growth.

H_0: Economic growth is not the cause of international migration.

H_0: ICT is not the cause of international migration.

H_0: International migration is not the cause of ICT.

4. EMPIRICAL FINDINGS AND RESULTS

Table 1 explains descriptive statistics. It can be observed that average economic growth (LGDP) is 8.95 % with standart deviation of 0.44 % and maximum of 9.43 %. Besides ICT (LICT) and international migration (LIMI) have a mean value of 15.81 % and 16.99 % respectively. Probability value of LGDP, LICT and LIMI are greater than 0.05. This indicates the normal distribution of the variables. Distributions of LICT, LIMI and LGDP are slightly left-skewed. Kurtosis of all three variables are lower than 3. That means distribution is platykurtic.

Table 1. Descriptive Statistics

	LICT	LIMI	LGDP
Mean	15.81167	16.99585	8.950828
Median	15.78506	17.25021	9.127452
Maximum	18.15463	17.76188	9.435003
Minimum	12.34533	15.82872	8.045268

Std. Dev.	1.819085	0.575602	0.445185
Skewness	-0.215281	-0.558030	-0.744480
Kurtosis	1.784383	2.005786	2.052328
Jarque-Bera	1.524515	2.047880	2.855495
Probability	0.466612	0.359177	0.239849
Sum	347.8567	373.9087	196.9182
Sum Sq. Dev.	69.49046	6.957676	4.161988
Observations	22	22	22

Source: Computed by author using E-views 10.0.

According to ADF Test results, Turkey's economic growth and international migration became stationary at first difference while ICT series became stationary at second difference. The precondition of the Johansen test is that all variables must be integrated in the same degree or all variables must not become stationary at the level. Thus, they are not adequate and sufficient for Johansen Cointegration Analysis. Due to the fact that some of the series are I (1) and some of them are I (2), the TY causality test method that allows to work with the different values of the series has been preferred.

Table 2. Results of ADF Unit Root Test

Unit Root Test	Augmented Dickey-Fuller			
Country	**Variables**	**Level**	**1st Difference**	**2nd Difference**
Turkey	**LICT**	-0.974789	-3.292075	-6.011369*
	LIMI	-0.915141	-5.856582*	
	LGDP	-1.204044	-3.572380**	

Note: Significance at 1 % is denoted by * and significance at 5 % is denoted by **.
Source: Computed by author using E-views 10.0.

Determining lagged values to be used in causality tests is an important problem. In order to make reliable relationships between variables and future predictions, appropriate delay values should be used in the analysis. Gujarati and Porter emphasized that the direction of causality is closely dependent on the number of delayed terms included in the model (Gujarati and Porter, 2014: 655). For this purpose, the VAR model was established for three variables. At this juncture, all the five available lag length criteria (LR, FPE, AIC, SC, HQ) were used. Table 3 shows the appropriate lag lengths according to different information criteria.

Table 3. The Optimal Lag Selection Criteria

Lag	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	NA	0.001760	2.170644	2.319039	2.191105
1	96.74359*	4.88e-06	-3.739613	-3.146032	-3.657766
2	13.27247	4.42e-06	-3.946201	-2.907434	-3.802969
3	10.34029	4.43e-06	-4.238737	-2.754784	-4.034120
4	10.35715	3.10e-06*	-5.310168*	-3.381029*	-5.044166*

Source: Computed by author using E-views 10.0.
Note: **LR:** Likelihood Ratio Criterion, **FPE:** Final Prediction Error Criterion **AIC:** Akaike Information Criterion, **SC:** Schwarz Information Criterion, **HQ:** Hannan-Quinn Information Criterion

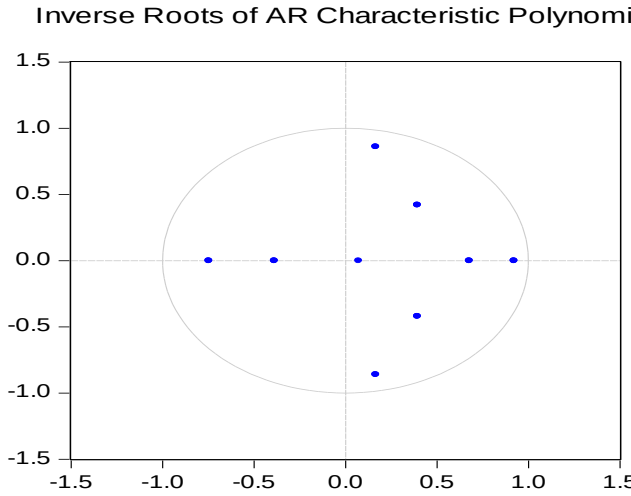
Looking at the results at Table 3, it is seen that FPE, AIC, SC and HQ information criteria give the lag length as 4. When the graphs of the model's error terms are analyzed, it was observed that LR's lag length recommendation as 1 eliminated the problem of autocorrelation. Therefore, it is appropriate to take the lag length of the model as 1. Once the lagged coefficients of the

VAR model is determined, the degree of maximum integration of variables (2) are added to the number of lags in the model. According to k + dmax = 1+2=3. Causality analysis was made within the framework of VAR model at 3nd degree. Table and graph of the inverse roots of AR characteristic polynomial are shown at Table 4 and Graph 1, respectively.

Table 4. AR Roots Table

Lag Specification 1 3	
Root	**Modulus**
0.921907	0.921907
0.166325- 0.860919i	0.876839
0.166325 + 0.860919i	0.876839
-0.746784	0.746784
0.678286	0.678286
0.394426-0.421029i	0.576921
0.394426 + 0421029i	0.576921
-0.387875	0.387875
0.071831	0.071831

Source: Computed by author using E-views 10.0.



Graph 1. Inverse Roots of AR Characteristic Polynomial
Source: Computed by author using E-views 10.0.

Results of Autocorrelation LM Test for Turkey are shown at Table 5. According to the results, there is no autocorrelation because probability value is higher than 0.05.

Table 5. Autocorrelation LM Test Results

Autocorrelation LM Test for BiH		
Lag	Prob.	LM Stat.
1	0.2755	1.400454
2	0.9410	0.328546
3	0.8410	0.488184
4	0.1207	2.038291

Source: Computed by author using E-views 10.0.

Because the series' maximum degree of integration is 2 (ie, since the series is I(2) at most), k + dmax = 1 + 2 = 3 lagged regression models were estimated. Created VAR model was estimated via SUR (Seemingly Unrelated Regression). MWALD test was applied on p=3 lag and the results are presented at Table 6.

Table 6. Toda-Yamamoto Causality Test Results

DEPENDENT VARIABLE: LIMI			
	X2	df	Probability
LICT	2.043822	3	0.7109
LGDP	1.777876	3	0.1824
DEPENDENT VARIABLE: LICT			
	X2	df	Probability
LIMI	3.655117	3	0.0559
LGDP	0.185572	3	0.6666
DEPENDENT VARIABLE: LGDP			
	X2	df	Probability
LIMI	9.523668	3	0.0020
LICT	9.879734	3	0.0017

Source: Computed by author using E-views 10.0.

According to TY causality test results, "H0= International migration is not the cause of economic growth" hypothesis is rejected because probability is lower than 1 % and 5 % level. International migration is the cause of economic growth. "H0= ICT is not the cause of economic growth" hypothesis is also rejected. Therefore we can say that ICT is the cause of economic growth. "H0=Economic growth is not the cause of ICT" and H0=Economic Growth is not the cause of international migration" hypotheses are accepted because probability is greater than 5 % level. Thus, it can be interpreted that there is a unidirectional relationship between economic growth-ICT and economic growth-international migration. "H0= ICT is not the cause of international migration" hypothesis is accepted because probability value is higher than 5 %. "H0=International migration is not the cause of ICT" hypothesis is accepted at 5 % probability level but rejected at 10 % probability level. As a result we can assert that international migration is the cause of ICT at 10 % for Turkey.

5. CONCLUSION

The study investigated the linkage between information and communication technology (ICT), economic growth and international migration with an annual time series data of Turkey for the period 1998-2019. The relationship between ICT, economic growth and international migration was analyzed by employing Toda-Yamamoto causality test in the study.

The empirical findings revealed that there is a unidirectional causality from international migration to economic growth at 5 % in the long run for Turkey. This result is in line with the findings from Meçik and Koyuncu (2020). Although the form of migration to Turkey is unclear in terms of skilled or unqualified labor force, international migrants, even including daytripper workers from neighbour countries, boost the economic activities especially in agriculture, construction and service sectors in Turkey. Migrants may also arrive with skills and contribute to human capital development of Turkey.

Another result is that ICT is the cause of economic growth at 5 % in Turkey. The ICT usage can make a substantial contribution to economic growth so Turkish government should improve the infrastructure of Internet and mobile phone with a conscious policy initiative. From the results obtained, it can be observed that it is important to increase the use of information and communication technologies, especially to use them actively at every stage of economic activities.

Lastly, it is observed that there is not a causal relationship between migration and ICT at 5 % for Turkey. We can only say that there is a unidirectional causality from migration to ICT at 10 %. This is inline with the study (Iqbal et al, 2020) in the literature. A strong, widespread and cheap information and communication infrastructure in the receiving country can attract international migrants to live, study or work. Some previous empirical studies suggested that low-skilled and forced migrants (refugees) are empowered by their strategic use of ICT. This situation can be somewhat controversial because especially low skilled migrants and Syrian refugees may be willing to stay and live in Turkey more as long as ICT infrastructure develops in Turkey. Thus, that situation may create other economic problems such as unemployment, pressure on wages and budget deficit.

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